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(56) Documents cited

GB A 2040994	US 4302218
GB 1357990	US 4099933
GB 0774606	US 4069024
GB 0665781	US 3867110
EP A1 0000442	

Note: EP A1 0000443 and GB A.2040994 are equivalent;

(58) Field of search
C5E

(54) **Gasification apparatus**

(57) A combined fluidised bed FB and fixed bed UB gasifier in which the fixed bed gasifier is arranged in the path of the effluent gases from the fluidised bed gasifier. The fixed bed fuel (coal) acts as a filter for the entrained particles, char, ash etc. from the fluidised bed and in return the effluent gases devolatilise the fixed bed fuel. The latter is thus broken down and falls, or is driven, into the fluidised bed. The fixed bed UB may be arranged either directly above the fluidised bed FB or (Figure 5) in an adjacent duct (27) from which it has to be driven up before falling into the fluidised bed.

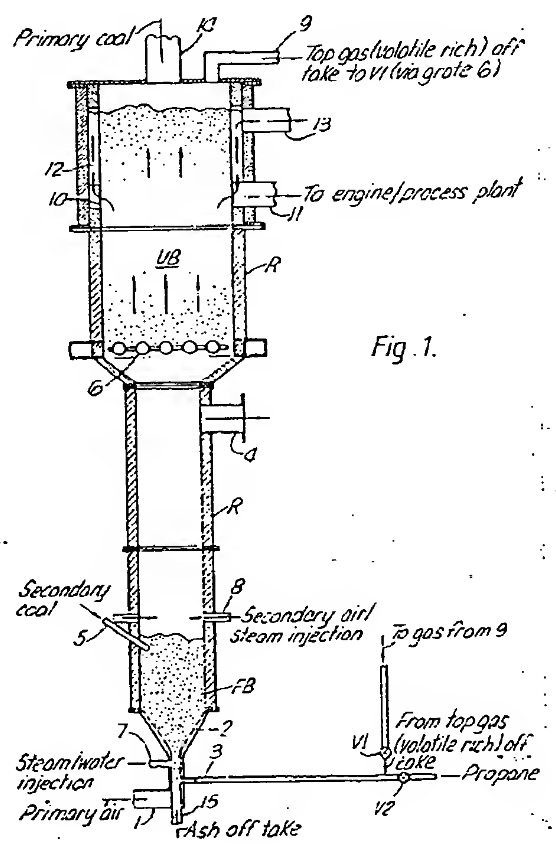
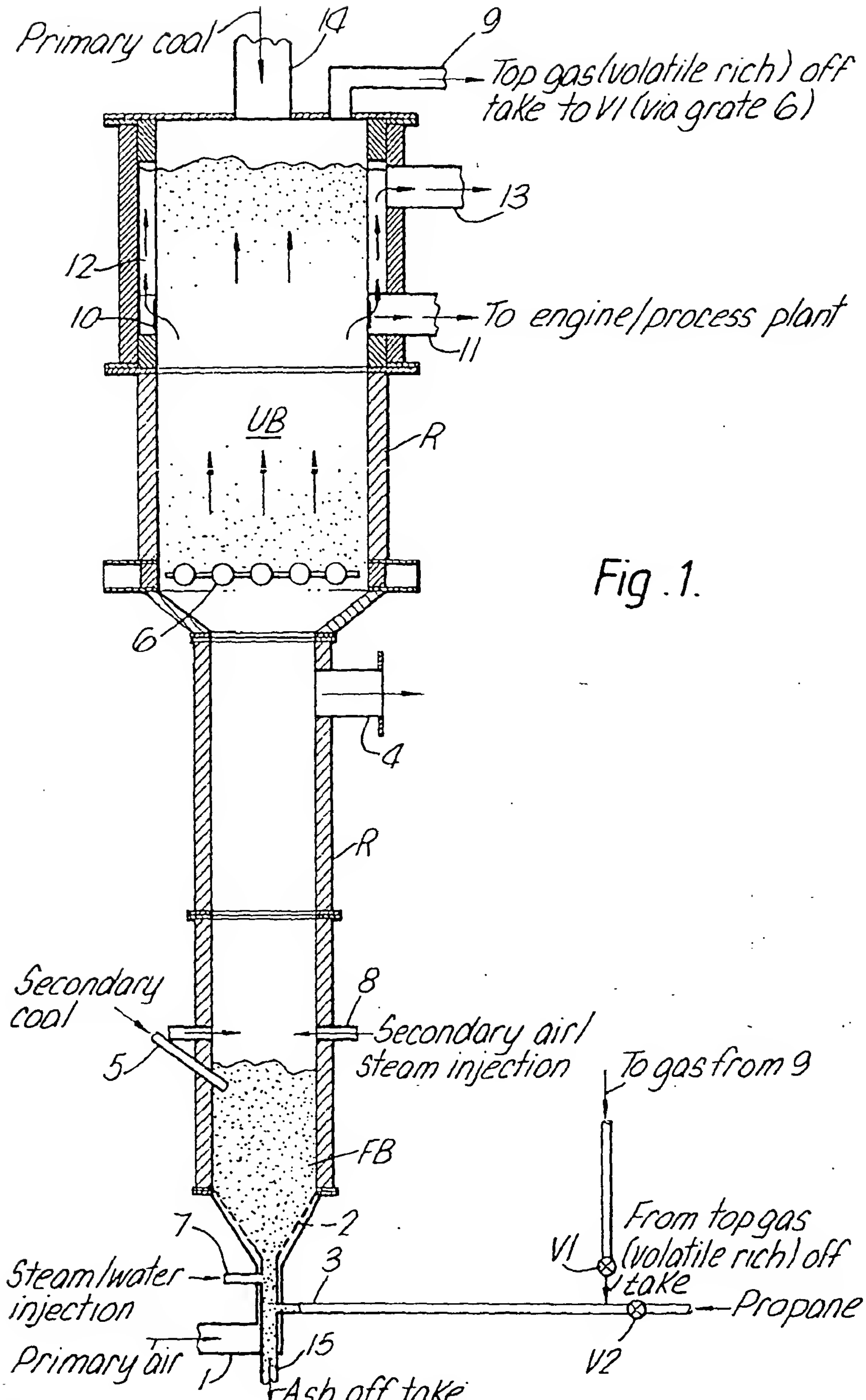


Fig. 1.

GB 2 164 660 A

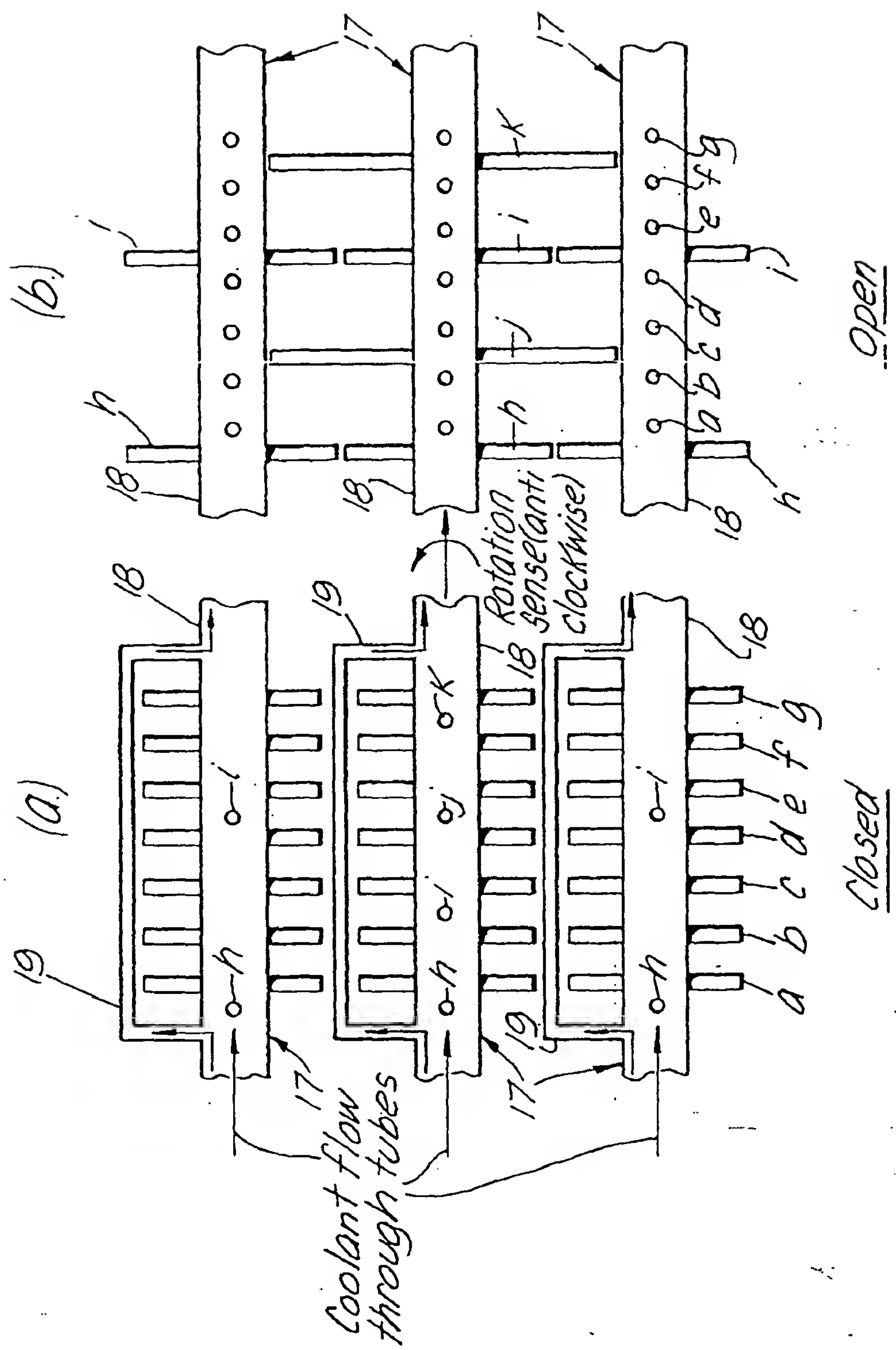
The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.



Primary coal
14
9
Top gas (volatile rich) off take to V1 (via grate 6)
13
12
10
To engine/process plant
11
UB
R
6
4
R
Secondary coal
8
Secondary air/ steam injection
5
To gas from 9
FB
7
2
Steam/water injection
3
V1
From top gas (volatile rich) off take
Propane
Primary air
15
1
V2
Ash off take

Fig. 1.

Fig. 2.


(a)
(b)
17
18
19
a b c d e f g
h i j k
Rotation sense (anti clockwise)
Coolant flow through tubes
Closed
Open

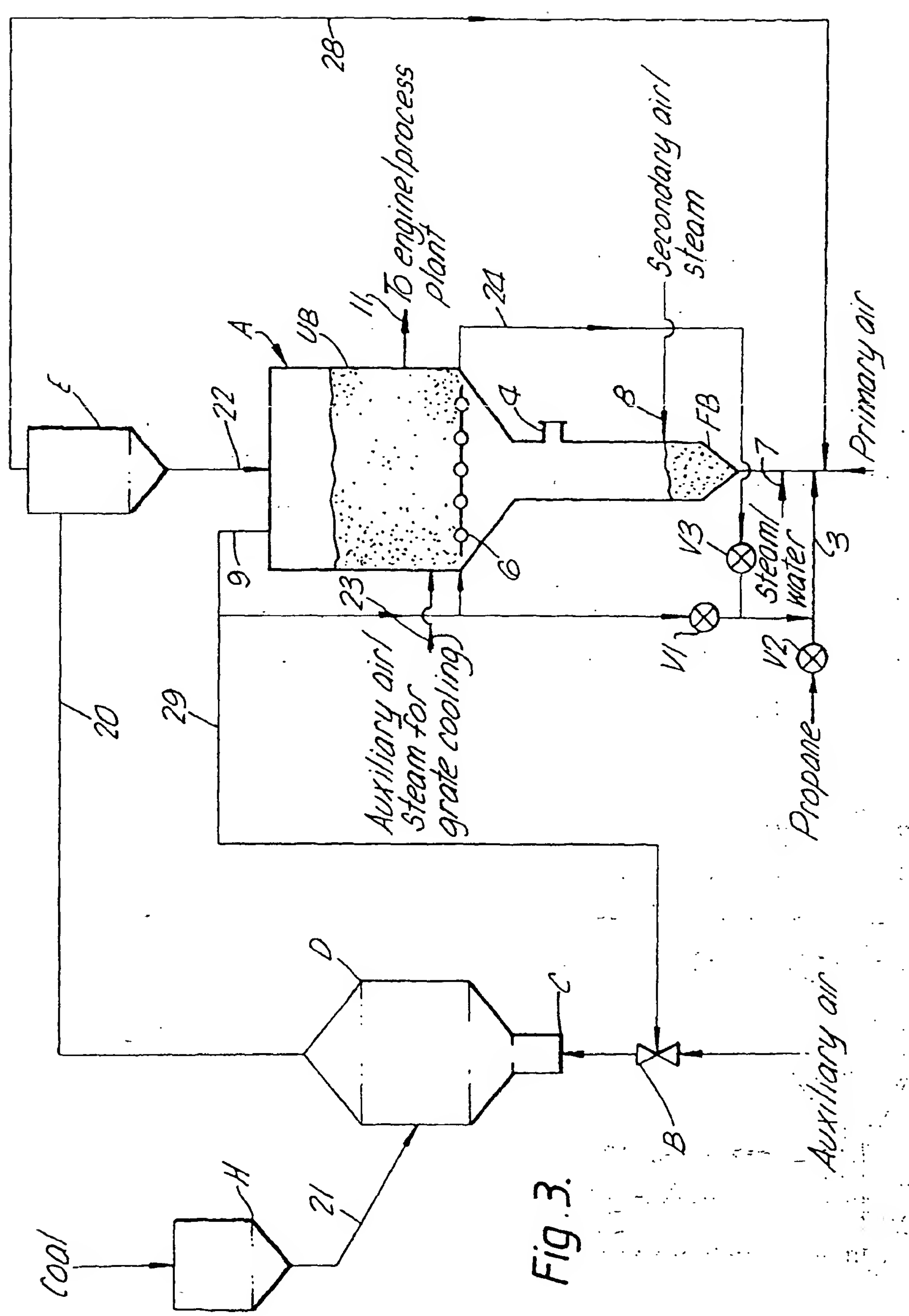
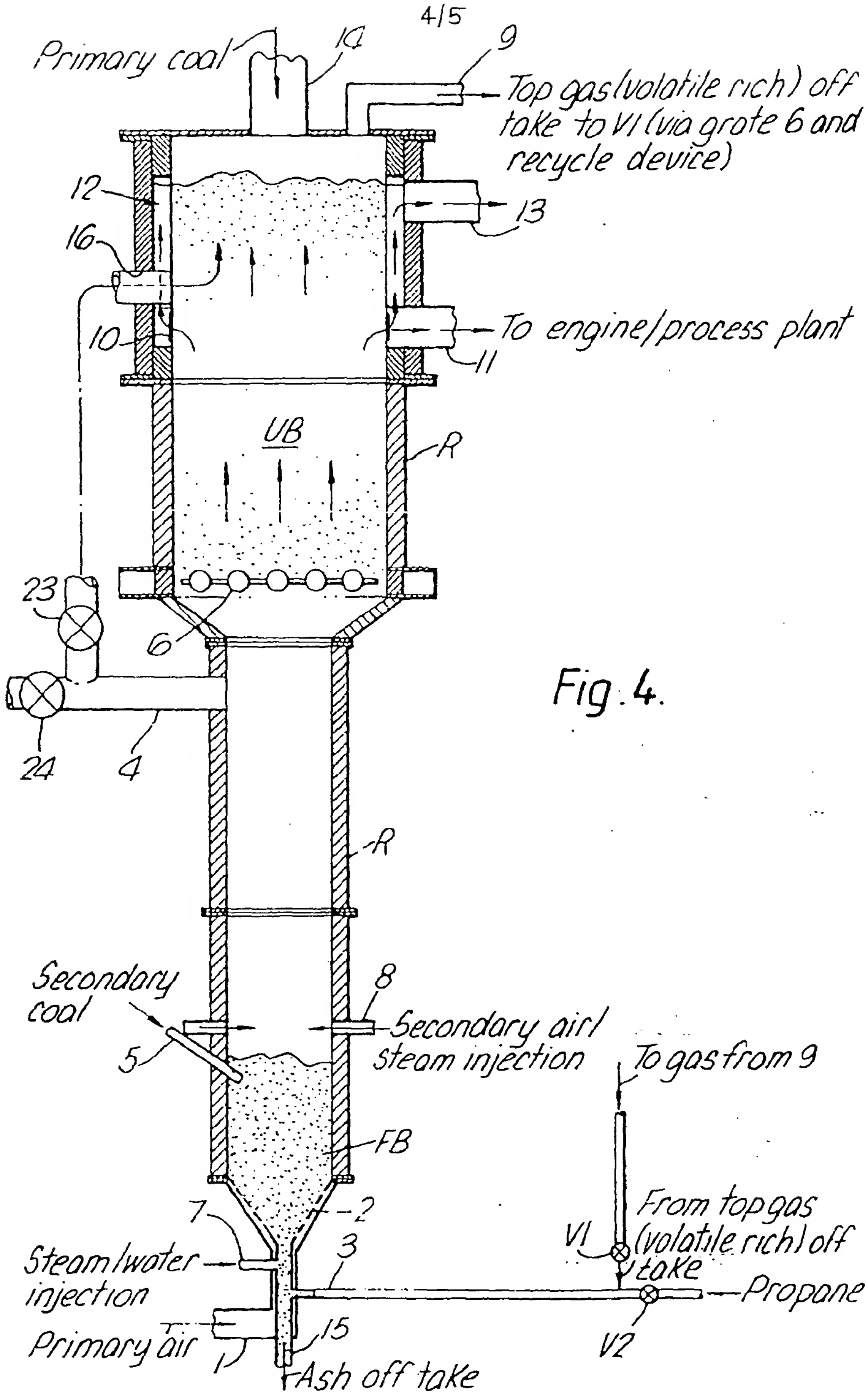

28
To engine/process plant
11
Secondary air/ steam
24
A
UB
E
22
4
8
FB
7
Primary air
9
23
6
V3
steam/ water
3
V1
V2
Auxiliary air/ steam for grate cooling
20
29
Propane
D
C
B
Auxiliary air
H
21
Coal

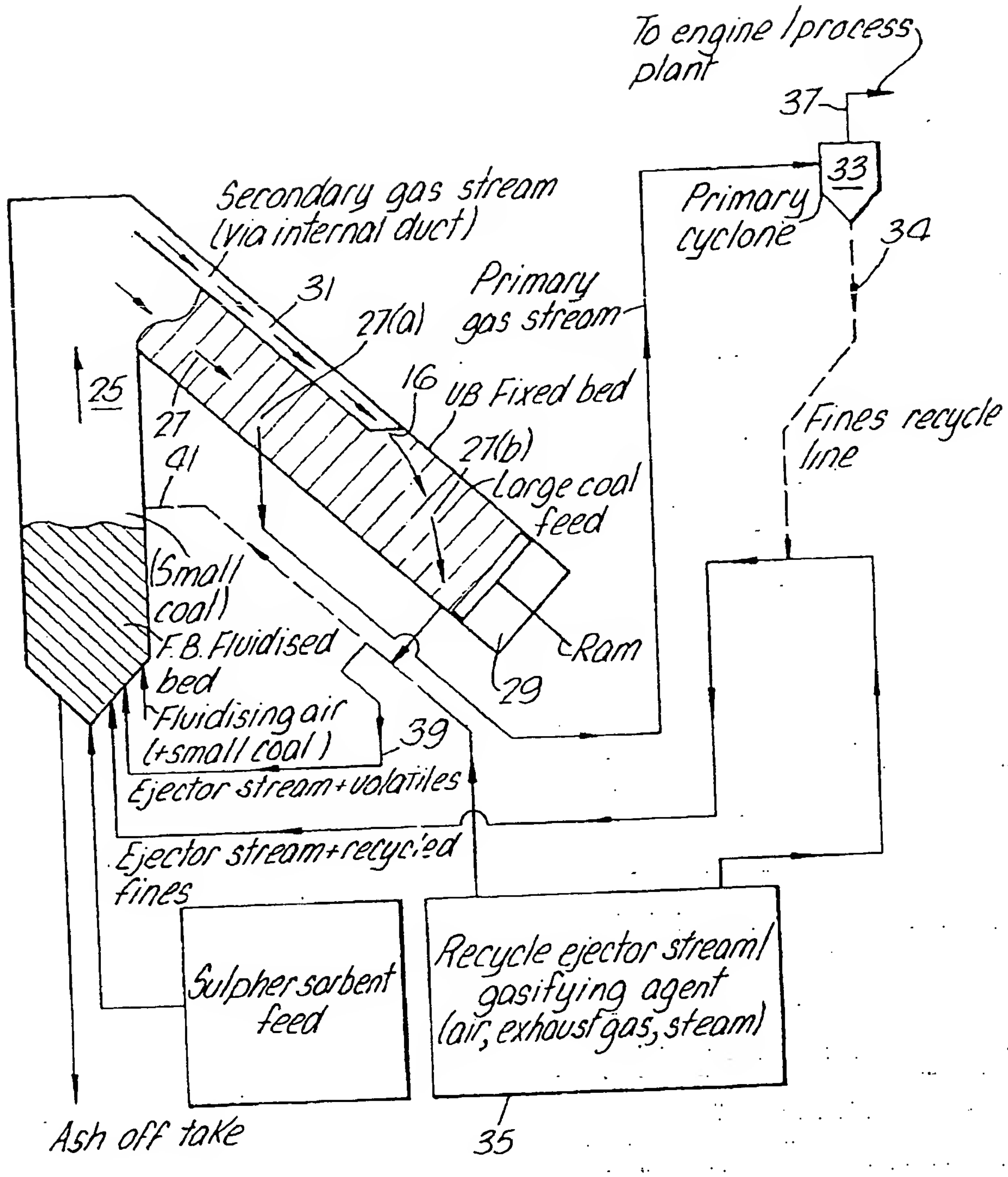
Fig. 3.



Primary coal
14
9
Top gas (volatile rich) off take to V1 (via grate 6 and recycle device)
12
13
16
10
To engine/process plant
11
UB
R
23
6
24
4
R
Secondary coal
8
5
Secondary air/ steam injection
To gas from 9
FB
7
2
3
From top gas (volatile rich) off take
V1
Steam/water injection
Propane
Primary air
1
15
V2
Ash off take

Fig. 4.

Fig .5.


To engine /process plant
37
33
Primary cyclone
34
Secondary gas stream (via internal duct)
31
27(a)
Primary gas stream
25
27
16
UB Fixed bed
41
27(b)
Large coal feed
Fines recycle line
(Small coal)
F.B. Fluidised bed
Fluidising air (+small coal)
Ram
29
39
Ejector stream+volatiles
Ejector stream+recycled fines
Sulpher sorbent feed
Recycle ejector stream/ gasifying agent (air, exhoust gas, steam)
Ash off take
35

SPECIFICATION

Gasification apparatus

The present invention relates to gasifiers in which a hydrocarbon fuel in solid or liquid form is converted into a combustible fuel gas. The principal combustible product is usually carbon monoxide together with hydrogen and some methane and higher hydrocarbons. The best known example of gasification technology is in the gasification of coal. The most well established gas technique i.e. fixed bed gasification, suffers from a number of drawbacks, principally the requirement for a graded size of coal feed and limitations on 'swelling number', gas content and ash fusion temperature. A 'fixed bed' gasifier is one in which the fuel bed is relatively stable. It is not, of course, absolutely 'fixed' since the fuel subsides in the gasification process. A 'fluidised bed' in contrast, is one in which the oxygenating gas/air flow rate is high, the fuel particles are of limited size, and they are kept in effectively constant fluid motion. The basic difference is therefore the size of the fuel particles and the gas flow rate through the bed.

Fixed bed gasifier units also tend to be high (working section height 10m), and they produce a gas with a considerable burden of tar and oil which requires to be removed for many purposes. A fluidised bed gasifier produces a gas without tars and oils and can tolerate a wide range of feedstock size (after an initial crushing below a particular top size), ash content and ash fusion temperature. It also allows the use of lime or dolomite in the bed as a sorbent for sulphur. However, it still suffers from a tendency for defluidization to occur with caking coals and a considerable quantity of fine material may be ejected from the bed, leading to a requirement for a high freeboard above the bed in order to consume these particles by reaction.

An object of the present invention is to provide gasification apparatus which at least partially avoids the disadvantages of both fixed and fluidised beds.

According to the present invention, gasification apparatus comprises a fixed bed gasifier arranged in the path of hot exhaust gases from a fluidised bed gasifier whereby solid fuel in the fixed bed gasifier acts as a filter for the gases and, on partial devolatilisation, falls into the fluidised bed gasifier to feed it. The invention thus incorporates features of both fixed and fluidised beds in a reciprocally advantageous manner.

By locating the fixed bed in the path of the exhaust from the fluidised bed, the fixed bed fuel (typically coal) is devolatilised so that no caking tendency (which might defluidise the fluidised bed) is left in the fuel which falls through the grate.

The fixed bed gasifier may be arranged above the fluidised bed gasifier so that fuel from the fixed bed gasifier is urged towards the fluidised bed gasifier by gravity.

Alternatively the gas path from the fluidised bed gasifier to the fixed bed gasifier may have an upward portion from the fluidised bed gasifier and a downward portion through the fixed bed gasifier, means being provided for driving solid fuel in the fixed bed gasifier upwards to a point at which it can fall into the fluidised bed gasifier. In this case the fixed bed gasifier may be contained within an inclined container, the angle of inclination of the container being such, in conjunction with the nature of the fuel in the fixed bed gasifier in operation, that the fuel in the fixed bed gasifier maintains its position in the container against gravity. The apparatus may then include a ram arranged to drive fuel in the fixed bed gasifier up the inclined container, and to retract and allow the admission of fresh fuel between the ram and the existing bed fuel.

The fixed bed gasifier may comprise a main gas output at an intermediate position in the gas path and an output for volatile-rich gases at the end of the gas path. There may be means for recycling the volatile-rich gases to the fluidised bed gasifier.

The gas path from the fluidised bed gasifier may separate into a main path through the initial part of the fixed bed gasifier to the gas output at the intermediate position in the fixed bed, and a diversion path around this initial part of the fixed bed gasifier to a re-entry position after the intermediate position.

In the case where the fixed bed gasifier is vertically above the fluidised bed gasifier the fixed bed gasifier may incorporate a grate which in use supports a bed of solid fuel, the grate having apertures of controllable size. The grate may also be adapted to feed fuel positively through the apertures. The grate may comprise a plurality of co-operating grate members, one or more of which grate members comprises at least two relatively inclined grids, and is rotatable about an axis lying in the plane of the grate so as to position one or other of the grids substantially in the plane of the grate and to positively feed fuel by engagement of the grid lying out of the plane of the grate with the fuel.

Each grid may comprise two or more sets of spaced rods the rod spacings being different so as to define different sized grate apertures according to which set lies in the plane of the grate.

According to another aspect of the invention, a gasification system may incorporate apparatus as aforesaid, and a separator arranged to feed fuel of relatively coarse particle size to the fixed bed gasifier and to feed fuel of relatively fine particle size to the fluidised bed gasifier. The system may also comprise a reaction vessel arranged to devolatilise fuel and feed devolatilised fuel to the separator.

The gasifier may function at atmospheric or elevated pressure.

Various embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, of which:

Figure 1 is a diagrammatic sectional elevation of gasification apparatus in accordance with the invention;

Figures 2(a) and *2(b)* are plan views showing in more detail the grate in the gasifier of Figure 1;

Figure 3 is a diagrammatic representation of a gasification system in accordance with the invention;

Figure 4 is a diagrammatic sectional view of a modification of the gasification apparatus of Figure 1; and

Figure 5 is a diagrammatic sectional view of alternative apparatus according to the invention.

Referring to Figure 1, the gasifier shown comprises a fluidised bed FB of burning coal and coke above which is supported an upper, fixed, bed UB of coal on a stainless steel feed grate 6. The gasifier is lined with refractory material R at its high temperature sections, as is conventional. The fixed bed is fed with coal at an inlet 14 and a temperature distribution is maintained by the hot exhaust gases from the fluidised bed FB such that the temperature of the fixed bed decreases gradually with height from a maximum of approximately 1000°C at its base. Fluidised bed FB is fed with fine coal from a secondary inlet 5 and with coke (formed by devolatilisation of the coal in bed UB) via feed grate 6, as will subsequently be described in more detail. The gravity feed of coke from the fixed bed is contrasted with an alternative transport arrangement to be described with reference to Figure 5.

The gasifier operates as follows.

Initially air, or an alternative oxygen-containing gaseous medium, is injected into a bed FB which comprises a mixture of ash and sand, and/or a sorbent for H_2S, if required, such as limestone, through a distributor 2, and fluidises the bed. Propane admitted at inlet 3 *via* valve V2 is ignited in the bed by an overbed torch (not shown) for initial warm-up purposes. The exhaust gases exit initially through a bypass outlet 4. Small coal, of particle diameter less than 12mm in this particular embodiment is then substituted for propane, entering the fluidised bed at inlet 5. Larger coal, in this embodiment sized between 12mm and 20mm, is supported in the fixed upper bed UB by feed grate 6 which is cooled initially by air flow through the hollow grate bars, as will be explained further. Subsequently, product gas from outlet 9 (in conjunction with steam if required) is used to cool the grate. Additional cooling is provided as required by injection of overbed steam at inlet 8, ensuring that the temperature immediately above grate 6 is below that required for ignition of coal. In this way, the only effect of interstitial oxygen and any convective updraught through the upper bed, in the initial regime of fluidised bed coal combustion with excess fluidisation air from inlet 1, is to pre-oxidize the coal in bed UB, inhibiting any caking tendency. The feed rate of coal via inlet 5 is increased, with cooling as necessary via steam from inlet 7, until the oxygen content in the effluent gases from the fluidised bed, i.e. the 'off-gas', is too low to permit combustion to occur in bed UB.

Gasification is then initiated by diverting flow through bed UB by closing bypass 4, and feeding coal from this bed by operation of the grate 6, as will be described with reference to Figure 2. Coal feed through inlet 5 and through grate 6 can be performed in parallel. Steam is admitted into the fluidised bed at 7 as required and reacts with the coal in the fluidised bed to generate carbon monoxide and hydrogen. Secondary air may be admitted at inlet 8. The running condition corresponds to a ratio of total air to total coal in which the proportion of air is about 20% of that required for a stoichiometric ratio. Gaseous exhaust from the fluidised bed section passes via grate 6 through the lower half of bed UB and is then divided into two streams; one stream passes directly through the bed to exit at fuel gas outlet 9, and the other passes through apertures 10 in the bed wall and exits at 11, where it is fed to an engine or process plant, or can be diverted through an annular passage 12 to promote heat transfer from the gas stream, through the inner wall, to the top half of the fixed bed, the gas stream then exiting at 13. Coal is supplied to bed UB at inlet 14 at a rate sufficient to maintain a constant level.

The hot fluidised bed off-gases devolatilise coal in the fixed bed UB, thereby destroying its caking properties, which would otherwise cause defluidisation of the fluidised bed when this coal was dropped into it. The fixed bed also acts reciprocally to condition the fluidised bed effluent gases by acting as a filter and removing the large quantities of char and ash carried over, and contributes to some additional carbon monoxide formation by reaction of CO_2 in the fluidised bed off-gases with carbon. The upward velocity through bed UB is sufficiently high to ensure good inertial collection efficiency, and the sticky porous surface of coal in various stages of conversion to char or coke promotes high particle retention efficiencies. The gas velocity in the fixed bed UB depends upon the change in area between the fluidised and fixed beds. In addition, the surface coatings of the larger coal/coke particles in the upper bed with small non-caking char and ash particles from the fluidised bed may reduce the tendency of these larger particles to agglomerate and hence to interfere with the downward flow of coal in the upper bed. The material, char, ash etc, ejected from the fluidised bed is returned with the large feed coal through the grate, and ash is rejected at 15. The top gas stream exiting at 9 is a significant exhaust component, and is rich in heavy volatiles and tars. This may be reinjected into the fluidised bed at 3 to crack these components into lighter gaseous components. The fluidised bed is run with a lower dense region at the distributor at a temperature of about 900°C. The injection of secondary air or a hot oxygen-containing exhaust stream at inlet 8 creates a zone of high temperature and high velocity in which there is a high concentration of suspended fuel particles, resulting in increased gasification rates. Such a high-temperature zone also contributes to increased gasification by carbon monoxide and hydrogen formation in the fixed bed UB.

The fuel gas produced in the gasifier is fed to an engine or a process plant via outlet 11 and/or outlet 13.

The gasifier of Figure 1 has the following advantages;

(i) The use of a fluidised bed means that sulphur

retention is possible in the bed using limestone or dolomite.

(ii) Total use can be made of coal without having to select only a particular size grade. Coal requirements for the upper bed UB can be screened out in situ, and the fines and undersize material used in the fluidised bed.

(iii) The filtering effect of bed UB greatly reduces the problem of fluidised bed carry-over, without the need for a large freeboard to ensure adequate solids residence time.

Figure 2 shows in more detail a part of the feed grate of Figure 1. Grate 6 comprises a plurality of adjacent elongate grate members 17 lying parallel in the plane of the grate, three of these grate members being shown in Figure 2. In Figure 2(b) the grate members are shown rotated by 90° relative to those in Figure 2(a). Each grate member 17 comprises a stainless steel main tube 18 which communicates with a bypass tube 19. Coolant gas (air and/or steam and/or product-gas from outlet 9) is passed through the tubes as shown.

Each grate member 17 is provided with two sets of inconel cross rods lying in respective perpendicular planes; namely one set a, b, c, d, e, f, g lying in the plane of the drawing in Figure 2(a) and another set (h and i on the two outer grate members and h, j, i, k on the central grate member) lying perpendicular to this plane. Thus each set of cross rods forms a grid which with the adjacent grate members defines a set of grate apertures whose size is determined by the length and spacing of the cross rods. The central grate member 17 shown in Figure 2 differs from the two outer grate members in that additional cross rods j, k of twice the usual length are provided in one set, as can best be seen in part b).

On rotation of the grate members 17 in, say the anticlockwise direction as shown, the upwardly projecting ends of the cross rods h, i, j, k rake the fuel supported on the grid and positively feed it through the larger apertures being formed as the cross-rods a to g swing out of the plane of the grate. Apertures of intermediate size can be formed by rotating the grate members by less than 90°. Thus fuel can be positively fed through the grate by rotating the grate members by approximately 90° or the fuel can be merely allowed to fall through the grate at a controlled rate by a suitable intermediate rotation of the grate members. It will be appreciated that as the coal in the fixed bed UB of Figure 1 devolatilises, the larger lumps of coal split and break up into smaller sizes which can then fall through the grate.

Figure 3 shows a gasification system comprising a gasifier A substantially as shown in Figure 1. The system utilises coal fed into a hooper H and air fed into gasifier A (at the fluidisation inlet 1) and into a reaction vessel D to generate combustible gas at outlet 11. The combustible gas, which consists mainly of carbon monoxide, hydrogen, methane and nitrogen, may be fed to an engine or to a process plant for example. A volatile-rich outlet stream of gas from gasifier A is drawn through a line 29 into an auxiliary air supply for vessel D through a venturi at B. This gas is ignited and burns stoichiometrically in a combustion chamber C. The hot, oxygen free exhaust gases from combustion chamber C vent into the conical base of the reaction vessel D. Coarsely crushed feed coal fed into vessel D via a hopper H forms a vigorously spouted bed in the vessel D. Drying and devolatilisation of the coal by rapid heating takes place here, and the vigorous recirculation within the reaction vessel, caused by spouted entry of fuel and gases, discourages agglomeration of the coal as it passes through the plastic regime. The path through vessel D contracts into a transport line 20 through which the devolatilised coal is conveyed upwards into a cyclone separator E. The design of the cyclone separator is such that the oversize 'cut' (i.e. the proportion of material of size greater than the separation level) rejected to the gasifier via feed line 22 is of the particle size range required for the fixed bed UB of gasifier A. The upper limit of this size range is fixed by the initial coal crushing. The complementary undersize stream containing the undersize particles (conveyed by a mixture of exhaust gases and volatiles) is injected into the base of gasifier A as a central spout (i.e. by way of a spout or nozzle entering the bed) via line 28, the secondary coal input 5 of Figure 1 being dispensed with. Feed grate 6 is included in a loop 24, (comprising grate 6, path 24, valve V3, gas entry 3, fluidised bed FB, fixed bed UB, product gas exit 9 and grate 6,) controlled by valves V1 and V3, and is cooled by circulation of product-gas through this loop. Additional cooling may be provided by injecting steam or air at inlet 23.

This extended system provides the following additional advantages:

(i) The ability to make full use of swelling coal without need for mechanical agitators to prevent seizing in the upper bed UB of the gasifier.

(ii) The need for minimal solids treatment and handling. The reduction to a coarse top size can be achieved by a simple sized reduction without need for grading, and the coal is pneumatically transported by a process gas stream for most of its passage.

A suitably sized sulphur sorbent (i.e. limestone) can be supplied with the feed coal if required. The particle size of this should be fine enough to ensure transport into the fluidised bed FB. The generation of fines in handling and transport is irrelevant as their ultimate destination is the fluidised bed gasifier.

Figure 4 shows a modification of the apparatus of Figure 1. The arrangement again comprises a fixed bed gasifier UB mounted over a fluidised bed gasifier FB so that coal in the fixed, upper, bed is urged downwardly by gravity through the grate 6 and into the fluidised bed. In Figure 1, when the start-up period is over and the fluidised bed is in operation, the outlet 4 is closed and remains closed. The 'off-gases' from the fluidised bed then make their way through the grate 6 and the initial part of the fixed bed to an intermediate position at which the outlet ports 10 are situated. Some of the

gases are vented at outlets 11 and 13 and some volatile-rich gases proceed through the remainder of the fixed bed to the gas outlet 9 for recirculation.

In the gasifier of Figure 4, the path of effluent gases from the fluidised bed separates, below the grate 6, one diverted stream, takes a 'diversion path' through outlet 4 through valve 23 and by way of ducts, not shown, to a re-entry position at port 16, after the position of the outlet ports 10.

The normal start-up procedure is effected by opening valve 24 and closing valve 23, this situation being reversed on running.

The main stream of effluent gases from the fluidised bed takes a 'main path' up through the grate 6, through the initial part of the fixed bed UB and (largely) out of the ports 10 as in Figure 1.

The diverted stream passes through the upper section of the fixed bed UB and out of the outlet 9 from where it may be recycled to the base of the fluidised bed (as in Figure 1) or it may be recycled as a secondary over (fluidised) bed stream in conjunction with secondary air. The mechanism of recycling and the position of re-entry port 16 in relation to outlet port 10 ensures that the pressure distribution within the fixed bed UB is such that the fluidised bed off-gas entering the fixed bed through grate 6 (the 'main stream') will exit almost entirely through port 10 as the main off-gas stream from the process. A small fraction will join the diverted stream and exit through outlet 9. None of the diverted stream will exit at 10. In this way full use will be made of the hot gas stream from outlet 4 in the drying and devolatilisation process in the upper part of the fixed bed UB, and char in this stream will be removed by the filtering action of sticky devolatilising coal and may reduce the tendency of these particles to agglomerate. Volatile fluids will emerge in the stream at 9 and a filtered gas stream free of tars will emerge at port 10. The diversion of the diverted stream below the grate level reduces any requirement for alteration of cross-sectional area between beds.

Figure 5 shows gasification apparatus incorporating a fluidised bed gasifier FB and a fixed bed gasifier UB as before, but in this case the fixed bed is arranged not above the fluidised bed but alongside it in a kind of folded arrangement. Thus, the path from the fluidised bed to the fixed bed has an initial upward portion 25 and a following downward portion 27 which includes the fixed bed gasifier UB.

In this case, the fixed bed UB is positioned in an inclined duct or container terminating at the top of the fluidised bed section. A ram 29 alternately retracts to admit large coal and advances to drive the bed upwards. The angle of slope is less than the angle of repose for the bed: in other words, the angle of inclination of the slope/container is such that, in conjunction with the nature of the fuel in the bed in operation, (its size, form, adhesion etc.) the bed maintains its position in the container against gravity.

In Figure 5 the diverted stream, that in Figure 4 exits from outlet 4, passes along an internal duct 31 thus bypassing the initial part 27(a) of the fixed bed and opening into the bed at the re-entry point 16. The diverted stream then passes through the latter part 27(b) of the fixed bed to the volatile gas outlet 9. The main stream passes through the initial part 27(a) of the fixed bed and emerges at an intermediate position, as before, at port 10. As in Figure 4, this intermediate position of port 10 is arranged before the re-entry of the diverted stream at point 16.

A primary cyclone 33 is shown in the undiverted stream, from which fines are recycled (on path 34) via an ejector stream provided by a source 35. This unit may also, of course, be employed in the previously described embodiments. The cleaned product gas is then produced by the cyclone separator 33 at output 37. The diverted stream, containing volatiles and unfiltered fines, emerges at outlet 9 and is recirculated to the fluidised bed via an ejecting fluid stream from the source 35 (e.g. air, a combustor or engine exhaust gas, or steam) which is itself a gasifying agent. Injection may be into the fluidised bed at the base, by way of path 39, or, as shown by path 41 in broken lines, overbed to provide a higher temperature, higher velocity freeboard zone. Small coal may be injected with fluidising air through a central spout in the base or overbed by gravity, or coal may be all fed as large coal to the inclined bed. This system has these further advantages.

(i) It solves any problems of coal flow in UB by providing positive feed.

(ii) It allows a reduction in height in comparison to the previous configurations (or an increase in fluidised bed residence time for the same height) and an increase in residence time in the fixed bed.

(iii) It eliminates a mechanical grate.

(iv) The inclined bed performs the function of coal elevation which in previous systems would require to be performed by an ancillary mechanism.

CLAIMS

1. Gasification apparatus comprising a fixed bed gasifier arranged in the path of hot exhaust gases from a fluidised bed gasifier whereby solid fuel in the fixed bed gasifier acts as a filter for said gases and, on partial devolatilisation, falls into the fluidised bed gasifier to feed it.

2. Gasification apparatus according to Claim 1 wherein said fixed bed gasifier is arranged above the fluidised bed gasifier so that fuel from the fixed bed gasifier is urged towards the fluidised bed gasifier by gravity.

3. Gasification apparatus according to Claim 1, wherein the gas path from the fluidised bed gasifier to the fixed bed gasifier has an upward portion from the fluidised bed gasifier and a downward portion through the fixed bed gasifier, means being provided for driving solid fuel in the fixed bed gasifier upwards to a point at which it can fall into the fluidised bed gasifier.

4. Gasification apparatus according to Claim 3 wherein the fixed bed gasifier is contained within an inclined container, the angle of inclination of

the container being such, in conjunction with the nature of the fuel in the fixed bed gasifier in operation, that the fuel in the fixed bed gasifier maintains its position in said container against gravity.

5. Gasification apparatus according to Claim 4, including a ram arranged to drive fuel in the fixed bed gasifier up the inclined container, and to retract and allow the admission of fresh fuel between the ram and the existing fixed bed fuel.

6. Gasification apparatus according to any preceding claim, wherein the fixed bed gasifier comprises a main gas output at an intermediate position in the gas path and an output for volatile-rich gases at the end of the gas path.

7. Gasification apparatus according to Claim 6, including means for recycling said volatile-rich gases to the fluidised bed gasifier.

8. Gasification apparatus according to Claim 6 or Claim 7, wherein the gas path from the fluidised bed gasifier separates into a main path through the initial part of the fixed bed gasifier to the gas output at said intermediate position in the fixed bed, and a diversion path around said initial part of the fixed bed gasifier to a re-entry position after said intermediate position.

9. Gasification apparatus according to Claim 2, wherein the fixed bed gasifier incorporates a grate which in use supports a bed of solid fuel, the grate having apertures of controllable size.

10. Gasification apparatus according to Claim 9, wherein said grate is adapted to feed fuel positively through said apertures.

11. Gasification apparatus according to Claim 10 wherein said grate comprises a plurality of co-operating grate members, one or more of which grate members comprises at least two relatively inclined grids, and is rotatable about an axis lying in the plane of the grate so as to position one or other of said grids substantially in the plane of the grate and to positively feed fuel by engagement of the grid lying out of the plane of the grate with the fuel.

12. Gasification apparatus according to Claim 11, wherein each said grid comprises two or more sets of spaced rods the rod spacings of said two or more sets being different so as to define different sized grate apertures according to which set lies in the plane of the grate.

13. A gasification system incorporating apparatus as claimed in any preceding Claim, a separator arranged to feed fuel of relatively coarse particle size to the fixed bed gasifier and to feed fuel of relatively fine particle size to the fluidised bed gasifier.

14. A gasification system according to Claim 13, further comprising a reaction vessel arranged to devolatilise fuel and feed devolatilised fuel to said separator.

15. A gasification system according to Claim 14, wherein said separator is a cyclone separator.

16. Gasification apparatus substantially as hereinbefore described with reference to Figures 1 and 2.

17. Gasification apparatus substantially as hereinbefore described with reference to Figures 4 & 2.

18. Gasification apparatus substantially as hereinbefore described with reference to Figure 5.

19. A gasification system substantially as hereinbefore described with reference to Figures 1, 2 and 3.

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